Overview of physics results from MAST towards ITER/DEMO and the MAST Upgrade - DTU Orbit (09/11/2017)

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New diagnostic, modelling and plant capability on the Mega Ampère Spherical Tokamak (MAST) have delivered important results in key areas for ITER/DEMO and the upcoming MAST Upgrade, a step towards future ST devices on the path to fusion currently under procurement. Micro-stability analysis of the pedestal highlights the potential roles of micro-tearing modes and kinetic ballooning modes for the pedestal formation. Mitigation of edge localized modes (ELM) using resonant magnetic perturbation has been demonstrated for toroidal mode numbers n = 3, 4, 6 with an ELM frequency increase by up to a factor of 9, compatible with pellet fuelling. The peak heat flux of mitigated and natural ELMs follows the same linear trend with ELM energy loss and the first ELM-resolved Ti measurements in the divertor region are shown. Measurements of flow shear and turbulence dynamics during L–H transitions show filaments erupting from the plasma edge whilst the full flow shear is still present. Off-axis neutral beam injection helps to strongly reduce the redistribution of fast-ions due to fishbone modes when compared to on-axis injection. Low-k ion-scale turbulence has been measured in L-mode and compared to global gyro-kinetic simulations. A statistical analysis of principal turbulence time scales shows them to be of comparable magnitude and reasonably correlated with turbulence decorrelation time. Te inside the island of a neoclassical tearing mode allow the analysis of the island evolution without assuming specific models for the heat flux. Other results include the discrepancy of the current profile evolution during the current ramp-up with solutions of the poloidal field diffusion equation, studies of the anomalous Doppler resonance compressional Alfvén eigenmodes, disruption mitigation studies and modelling of the new divertor design for MAST Upgrade. The novel 3D electron Bernstein synthetic imaging shows promising first data sensitive to the edge current profile and flows.

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